INVENTIONS & INNOVATION

Project Fact Sheet

Deep-Discharge Zinc-Bromine Battery Module Offers Megawatts Capacity

Breakthrough technology increases load-leveling efficiency and offers longer cycle life with less weight than conventional lead-acid batteries

Benefits

- Improves battery efficiency and reduces emissions of electricity generation through load leveling
- Allows complete battery discharge, improving battery capacity and extending cycle life
- Increases battery energy density, providing more energy at less weight
- Modular construction allows for sizing and portability of systems to suit multiple applications and needs
- Reduces disposal concerns and costs associated with lead-acid batteries, because only the battery stack must be replaced
- Lowers fabrication costs through use of less expensive plastics and vibration welding techniques
- Improves cost effectiveness of solar, wind, and other renewable technologies by allowing power delivery during peak consumption
- Available as a highly reliable power-delivery option for mission-critical operations

Applications

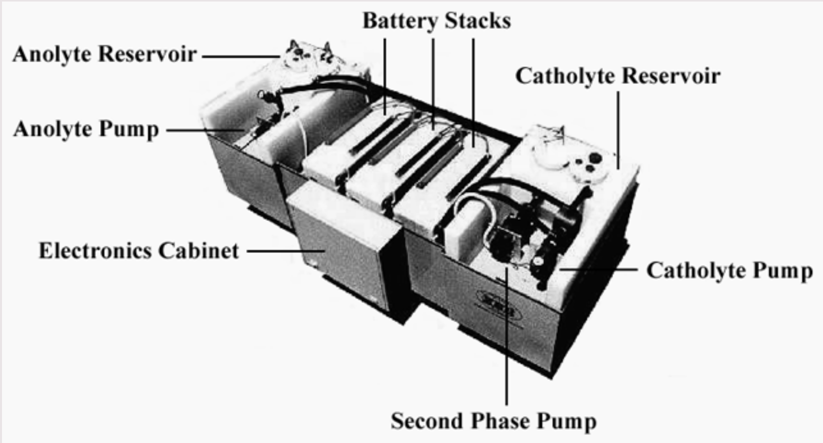
The F2500 zinc-bromine battery module is primarily applicable as a load-leveling technology for use by electric utility and industrial companies. The batteries have other energy-storage applications as well, especially in renewable-energy and remote-area power systems. Additionally, the batteries may prove useful in electric lawn mowers, golf carts, and wheel chairs.

Both industrial and commercial customers have been hard hit by peak-power price shocks at one time or another. To provide adequate power supplies during demand peak energy-use hours, large utilities use load-leveling devices to store excess power generated during off-peak hours. This helps utilities and industrial users avoid having to install additional power generation equipment that would be started and run during peak hours, then shut down during off-peak hours. Load-leveling devices allow base-load generating systems to consistently operate at full capacity, providing energy with greater efficiency than peak-load plants fired with less-efficient equipment and operating at lower efficiency during start-up and shutdown cycles.

The three primary options for load leveling include pumped storage of water, compressed air storage, and storage batteries. A new storage battery called the F2500 is a transportable energy system, which uses a zinc-bromine flow battery. Zinc-bromine batteries have moderate energy density, good power density, and significantly better cycling performance than conventional lead/acid batteries, particularly when deeply discharged on each cycle.

The separate storage of bromine in this new technology allows the system to operate similarly to a fuel cell. Instead of requiring complete replacement, like lead-acid batteries, the zinc-bromine battery can be refurbished through replacement of just the battery stack, with the bromine-storage system, pumps, and piping left intact for reuse. The F2500 zinc-bromine battery module will allow customers to purchase lower-cost power or generate on-site power and then use it for reducing peak-power purchases.

The ZBB Flow (F2500) Zinc-Bromine Battery



The new F2500 zinc-bromine battery developed by ZBB Energy Corporation improves efficiency and reduces emissions of electric power generation while also reducing the disposal dilemmas and costs associated with lead-acid batteries.

Project Description

Goal: Develop a modular flow-through zinc-bromine battery for load leveling, peak shaving, and distributed resource uses by electric utility companies.

The zinc-bromine battery is a flow battery consisting of an electrochemical reactor through which electrolyte is circulated from external storage tanks, past zinc reactor plates in a battery stack. The electrolyte is a pumpable fluid containing bromine stored in the form of a complex salt. The complexing agent decreases the vapor pressure of the bromine to make storage and system operation safer. Changes in electrolytes can modify power characteristics of the battery.

The zinc-bromine battery is made from cost-competitive, high-density polyethylene plastic, which reduces manufacturing and disposal costs compared to other battery types. In addition, the zinc-bromine battery offers 2 to 3 times the energy density of current lead-acid batteries, delivering increased energy with reduced weight. Unlike most other battery systems, the zinc-bromine battery cycle life is not degraded by deep discharging, and the lack of degradation of cathode active components contributes to long cycle life. The battery can be completely 100 percent discharged thousands of times without damage. ZBB Energy Corporation is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Completed testing of production prototype on Detroit Edison circuit. Subsequent testing is being conducted at ZBB and at a second Detroit Edison circuit during summer 2001.

- Completed development of cost-shared installations in partnership with utility company. See www.dteenergy.com/aboutdte/news/975444541808.html for additional details.

- ZBB Energy Corporation continues to implement means of reducing cost of fabrication, assembly, and testing.

- The Department of Energy's (DOE) Energy Storage Program, through Sandia National Laboratories, has provided significant developmental and testing support for this innovative technology. Additional support from the Inventions and Innovation Program in DOE's Office of Industrial Technologies has helped ZBB Energy Corporation develop certain critical components of the technology.

Economics and Commercial Potential

The use of zinc-bromine batteries for utility load leveling will allow power generators to rely more fully on base-load equipment rather than on less-efficient peak systems often used for peak-power generation. Eliminating the low-efficiency start-up and shutdown operation of peak-load generators also improves energy efficiency. At the scale of large utility operations, these savings are significant. Nationally, using zinc-bromine batteries for load leveling could allow for the equivalent crude oil savings of several million barrels per year.

In the United States, the economic benefit from using batteries for energy storage at electric utilities is estimated to be $57 billion on the supply side; of that, $13 billion on the demand side could be available to industry if peak consumption trends follow base consumption, i.e., industry consumes one-third. Specifically within the renewables niche, savings in facility deferral and demand peak reduction is estimated to be $40.8 billion.

A prototype of the F2500 zinc-bromine battery has been constructed and tested by Detroit Edison to demonstrate the validity of the technology. The major challenge now facing this technology is the high initial cost at low-volume production rates. The economics of production are expected to be much more favorable when large-volume runs become feasible, but production costs must be verified before large-scale commercialization takes place. At higher production levels, the system is expected to be priced competitively with lead-acid batteries, while offering longer, increased cycle life and nearly complete recyclability.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and to conduct early development. Ideas that have significant energy-savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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